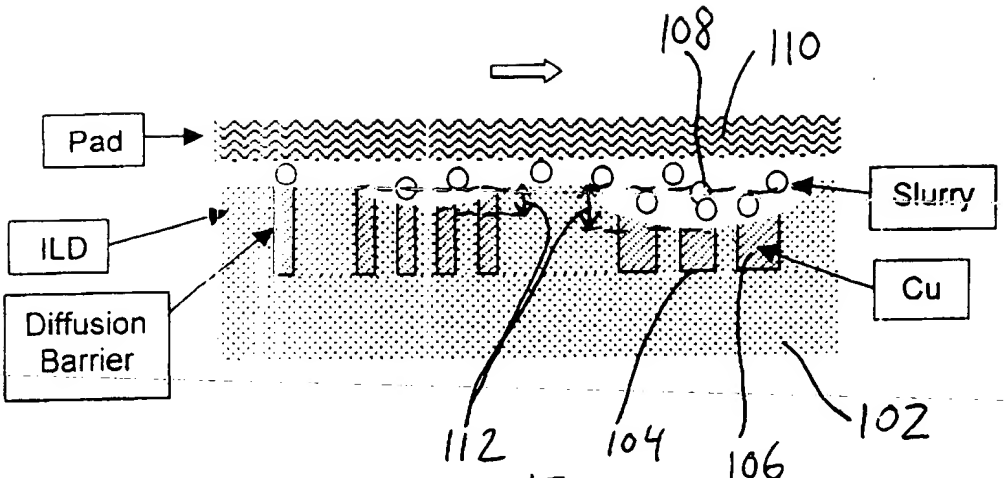

Fig. 1

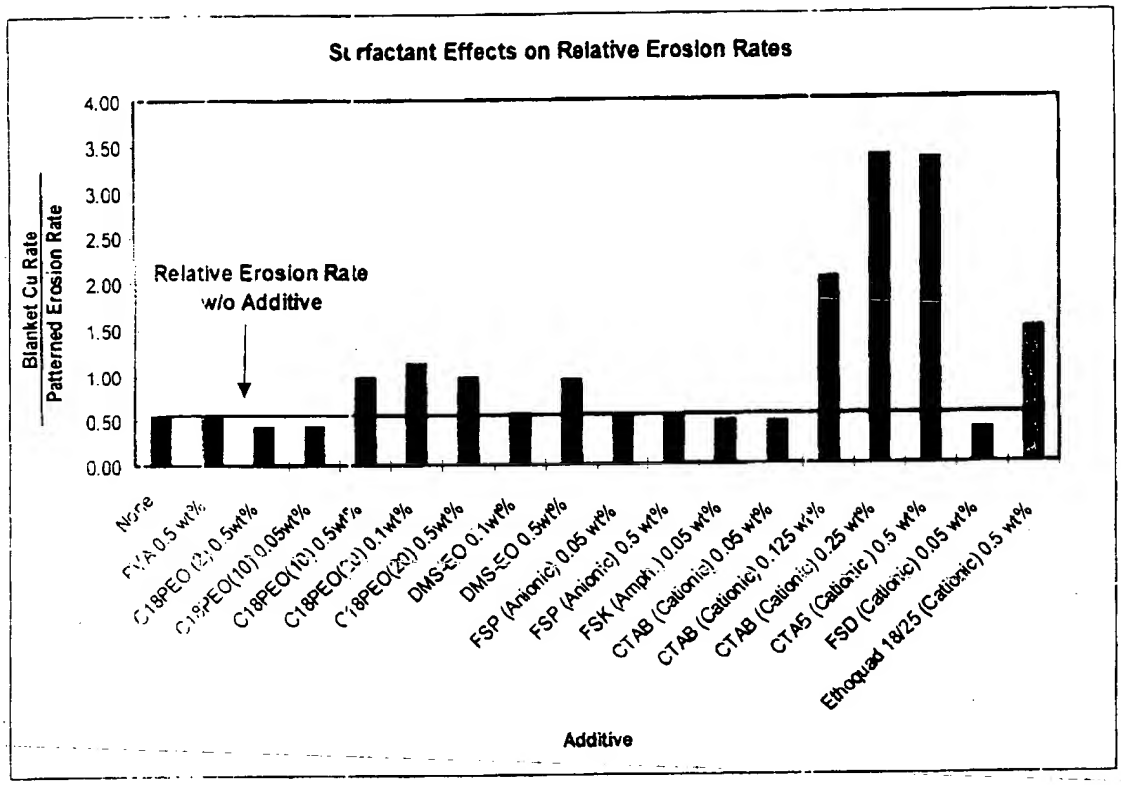
Surfactant Effects on Relative Erosion Rates
Blanket Cu Rate / Patterned Erosion Rate
4.00
3.50
3.00
2.50
2.00
1.50
1.00
0.50
0.00
Relative Erosion Rate w/o Additive
None
FSA 0.5 wt%
C18PEO(2) 0.5wt%
C18PEO(10) 0.05wt%
C18PEO(10) 0.5wt%
C18PEO(20) 0.1wt%
C18PEO(20) 0.5wt%
DMS-EO 0.1wt%
DMS-EO 0.5wt%
FSP (Anionic) 0.05 wt%
FSP (Anionic) 0.5 wt%
FSK (Ampho.) 0.05 wt%
CTAB (Cationic) 0.05 wt%
CTAB (Cationic) 0.125 wt%
CTAB (Cationic) 0.25 wt%
CTA5 (Cationic) 0.5 wt%
FSD (Cationic) 0.05 wt%
Ethoquad 18/25 (Cationic) 0.5 wt%
Additive

Fig. 2

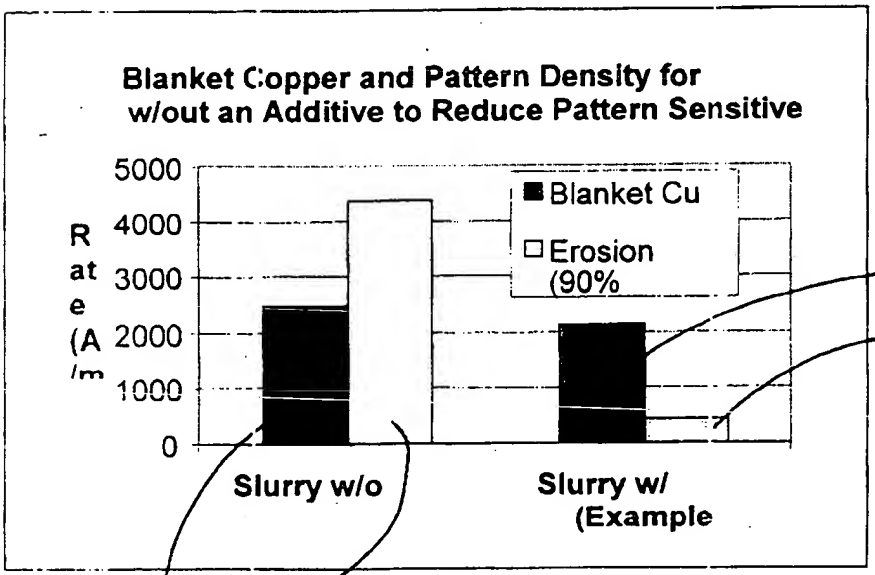
Blanket Copper and Pattern Density for w/out an Additive to Reduce Pattern Sensitive
Rate (Å/m
5000
4000
3000
2000
1000
0
Blanket Cu
Erosion (90%
Slurry w/o
Slurry w/ (Example
306
308
302
304

Fig. 3

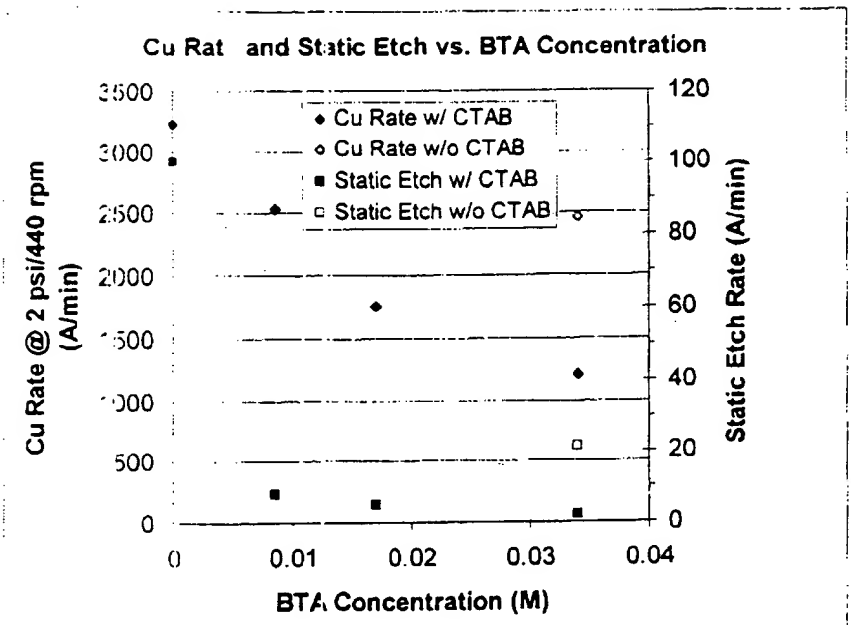
Cu Rat and Static Etch vs. BTA Concentration
Cu Rate w/ CTAB
Cu Rate w/o CTAB
Static Etch w/ CTAB
Static Etch w/o CTAB
Cu Rate @ 2 psi/440 rpm (A/min)
Static Etch Rate (A/min)
BTA Concentration (M)
3500
3000
2500
2000
500
0
120
100
80
60
40
20
0
0.01
0.02
0.03
0.04

Fig. 4

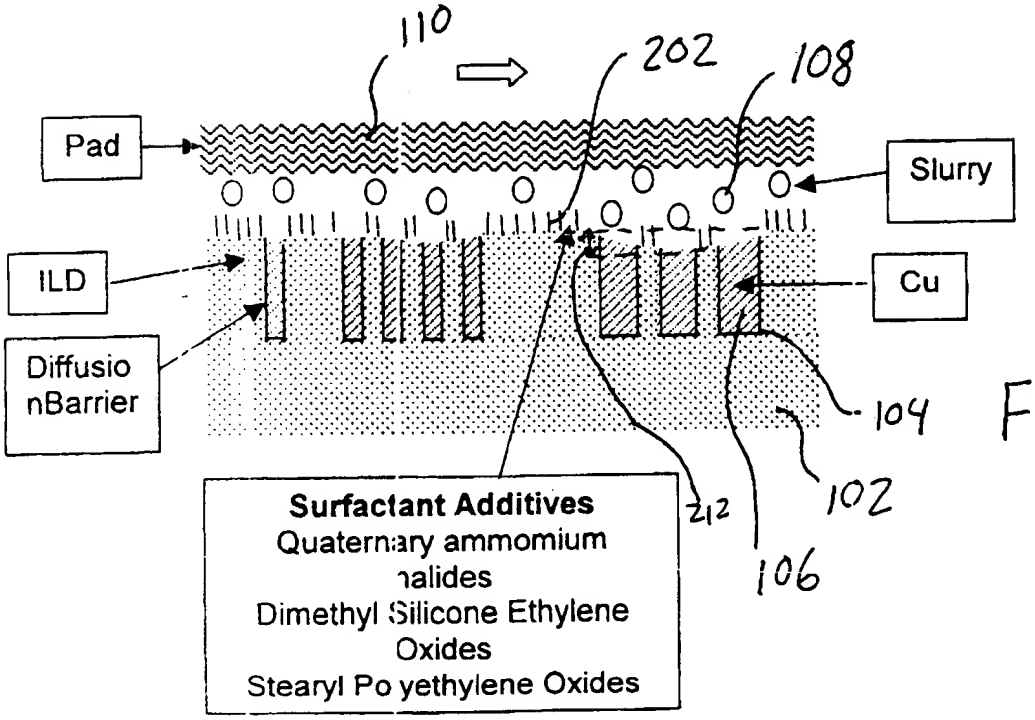
110
202
108
Pad
Slurry
ILD
Cu
Diffusio nBarrier
104
102
106
212
Surfactant Additives
Quaternary ammomium halides
Dimethyl Silicone Ethylene Oxides
Stearyl Po yethylene Oxides

Fig. 5

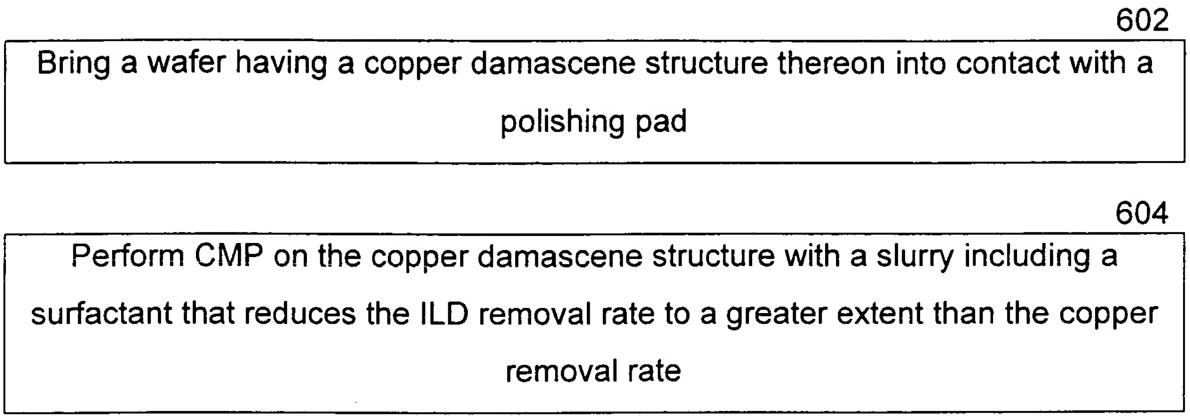
602
Bring a wafer having a copper damascene structure thereon into contact with a polishing pad
604
Perform CMP on the copper damascene structure with a slurry including a surfactant that reduces the ILD removal rate to a greater extent than the copper removal rate

Fig. 6

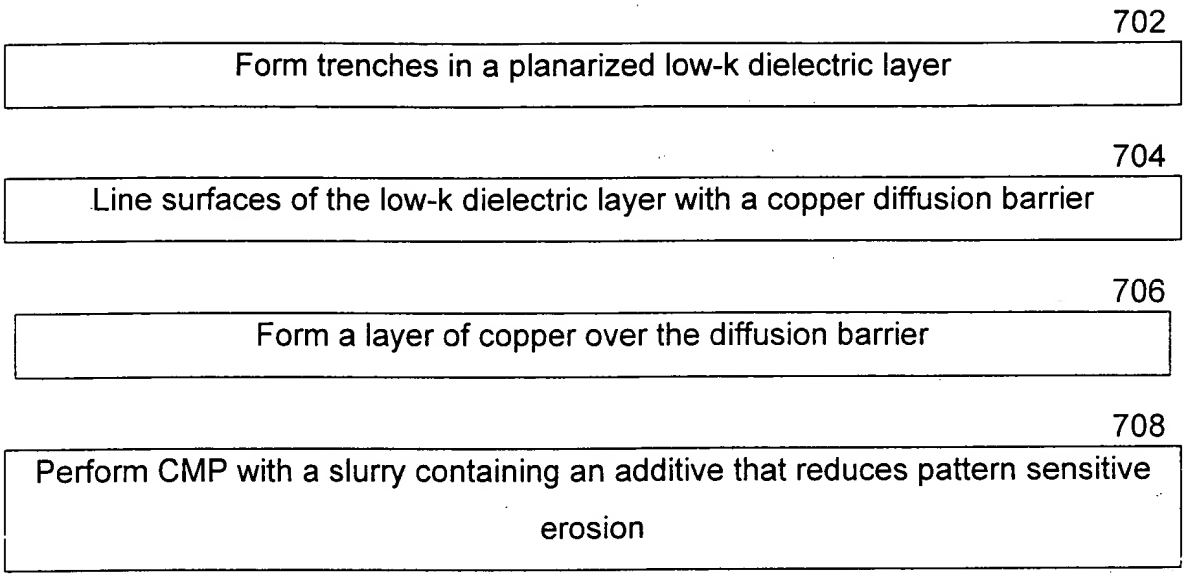
702
Form trenches in a planarized low-k dielectric layer
704
Line surfaces of the low-k dielectric layer with a copper diffusion barrier
706
Form a layer of copper over the diffusion barrier
708
Perform CMP with a slurry containing an additive that reduces pattern sensitive erosion

Fig. 7

802

Create a mixture by combining an abrasive and an oxidizer with water

804

Add a surfactant to the mixture, the surfactant being characterized in that it reduces ILD removal rate without significantly affecting copper removal rate when chemically mechanically polishing copper with the mixture

Fig. 8

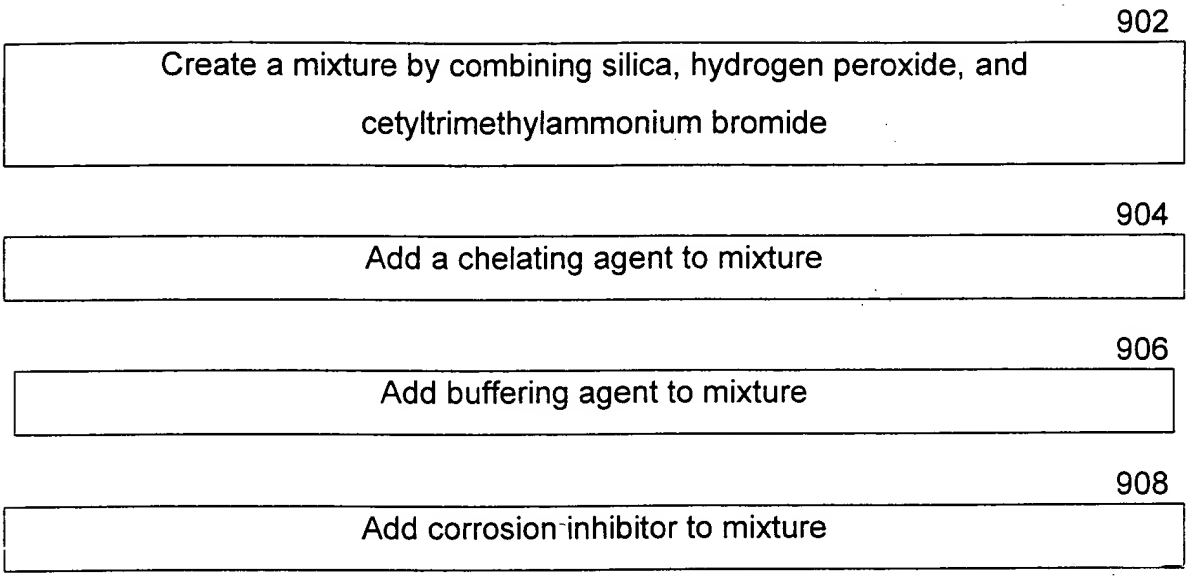
902
Create a mixture by combining silica, hydrogen peroxide, and cetyltrimethylammonium bromide
904
Add a chelating agent to mixture
906
Add buffering agent to mixture
908
Add corrosion inhibitor to mixture

Fig. 9

Table 1

Abreviation	Name	Chemical Formula	Surfactant Type	ILD Interaction Site
PVA 0.5 wt%	Polyvinylalchohol	[-CH2CH(OH)-] (MW = 85,000-146,000)	nonionic	Si-O-Si, OH
C18PEO (2)	Polyoxyethlene(2)stearylether	$C_{18}H_{37}(OCH_2CH_2)_2OH$	nonionic	Si-O-Si, OH
C18PEO(10)	Polyoxyethlene(10)stearylether	$C_{18}H_{37}(OCH_2CH_2)_{10}OH$	nonionic	Si-O-Si, OH
C18PEO(20)	Polyoxyethlene(20)stearylether	$C_{18}H_{37}(OCH_2CH_2)_{20}OH$	nonionic	Si-O-Si, OH
DMS-EO	Ethylene oxide modified	[illegible]	nonionic	Si-O-Si, OH
FSP	Phosphate fluorosurfactant	$[F(CF_2CF_2)_zCH_2CH_2O]_xP(O)(ONH_4)_y$	anionic	SiOH+
FSK	Amphoteric Flurosurfactant	$F(CF_2CF_2)_yCH_2CH_2O(Ac)CH_2N^+(CH_3)_2CH_2COO^-$	amphoteric	SiO-, SiOH+
CTAB	Cetyltrimethylammonium bromide	$C_{16}H_{33}N(CH_3)_3Br$	cationic	SiO-
FSD	Quaternary Ammonium	$F(CF_2CF_2)_yalkylN^+RCl^-$(Proprietary)	cationic	SiO-
Ethoquad 18/25	Octadecylmethylpolyoxyethylene(15)ammonium	$RN(CH_3)[(CH_2CH_2O)_{\sim 7.5}H][(CH_2CH_2O)_{\sim 7.5}H]$	cationic	SiO-
K-Oleate 0.5	Potasslum Oleate	$CH_3(CH_2)_7CH=CH(CH_2)_7CO_2K$	anionic	SiOH+

*Me=CH3, R=hydrocarbon group, alkyl = Alkyl group